Delivery Program of the High-Frequency Equipment

Division of Telefunken

Lieferprogramm des Geschaeftszweiges 'Hoga' -
Hochfrequenzgeraete und Anlagen - of Telefunken,
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TELEFUNKEN

GESELLSCHAFT FUER DRAHTLOSE TELEGRAPHIE M.B.H.

(CORPORATION FOR WIRELESS TELEGRAPHY, INC.)

Berlin SW 61, Mehringdamm 32 - 34

PRODUCTION PROGRAM

OF THE "HOGA" SUBSIDIARY [OF TELEFUNKEN]

RADIO-FREQUENCY EQUIPMENT AND INSTALLATIONS

for

Radio Broadcast Transmitting Service

Commercial Transmitting and Receiving Service

(Radio Communications and Radio Navigation)

Electronic Heating for Industrial Fabrication Processes

CONTENTS

GENERAL

The history of German radio telegraphy and telephony, of radio broadcasting, -- and of radio in general -- is inseparably tied up with the history of the TELEFUNKEN GESELLSCHAFT FUER DRAHTLOSE TELEGRAPHIE, INC., Berlin; this company developed radio telegraphy in Germany theoretically and practically and brought it to its present-day level. In this way the company has provided an outstanding example of German research work -- under free conditions of development -- achieving the highest practical results if technical competence and scientific work are harmoniously blended together. The results of this are in evidence in radio broadcasting -- with its significance for the economy and society -- in commercial communications on land and at sea, in traffic safety and police radio, in radio navigation, in military radio, and in recent times also in industrial high-frequency techniques. Finally, as the leading, largest and oldest radio firm in Germany, Telefunken also dominates electro-acoustics with its diverse and numerous fields of application, and was in first place in the development of picture telegraphy and television. Telefunken's importance not only in the manufacturing economy, but also in the national economy is based on this diversity, and with it the company's eminence in the world economy. The trademark of the firm, the Telefunken-Star, thus became the sign of German quality throughout the world and for the whole radio industry.

The reconstruction began in 1945, after almost complete loss of all factories and installations, and continued unerringly in the old Telefunken transition. The experience of decades in the development, design and manufacture of radio communication means enables

the firm to consider the special demands of its diverse types of customers, such as radio broadcasting companies, government agencies, industries, traffic control, police, press, etc. It further makes possible the design of installations and apparatus incorporating the most recent advances of high-frequency techniques. The many radio stations erected by Telefunken after 1945, in addition to the installations for industrial high-frequency heating, represent milestones in the re-conquest of Telefunken's world prominence. As examples may be cited the 100-kilowatt stations Koenigswusterhausen and Rias-Berlin, the continuing expansion of the NWDR radio network [NWDR = North-West German Radio -- Translator] including the high-power FM-VHF transmitters; further examples are communication transmitters for important domestic and foreign press agencies, overseas sending installations for commercial communications of the Deutsche Post (German Mail Service), FM-VHF radio telephone installations for police service, fire departments, traffic control and similar services, transmitting and receiving apparatus for navigation and v.h.f. relays as a substitute for cable connections. In particular, the recent achievements in the field of v.h.f. (the new 10-kw FM-VHF radio stations which are complemented by the recently developed German high-power tubes need only be mentioned) give evidence of German quality work.

The present summary is intended as a brief survey of the Telefunken production program in the Hoga field of activity which comprises radio-frequency apparatus and installations for radio broadcasting and commercial communications. The following supply program gives a picture of Telefunken's present-day capabilities and the continuous progress in the field of high-frequency tech-

niques.

The many areas of the Hoga distribution program can only be shortly treated in this information booklet. Separate pamphlets for the various special fields are available on request.

I. TRANSMITTER INSTALLATIONS

Telefunken transmitter installations for radio broadcasting, commercial communications and other services are in accord with the international requirements of the CCIR, or the directives of the World Radio Agreement of Atlantic City; they are manufactured in the customary power output ratings as well as for all available frequency channels.

A. RADIO BROADCASTING TRANSMITTERS

1. Long Wave, Medium Wave and Short Wave Radio Transmitters

Telefunken radio transmitters are equipped with high-quality quartz crystal control and have a frequency stability of better than $1 \cdot 10^{-7}$ over a twenty-four hour period. In special cases, i.e., particularly for common-frequency operation independent of line control in the medium-wave range, Telefunken supplies a control attachment equipped with double thermostats having an especially low temperature coefficient, which has a frequency stability of $1 \cdot 10^{-8}$ over a twenty-four hour period. A built-in frequency comparison device with a cathode-ray tube as indicator serves for monitoring both control devices of this installation; any frequency deviation which may be present is displayed on the cathode-ray indicator as a phase shift and can be corrected by fine tuning of a tuning capacitor. In addition, this installation permits synchronization with a master transmitter during "off-the-air" periods in conjunction with a built-in receiver. This frequency control equipment has such excellent frequency stability that it is sufficient to make frequency or phase corrections for common-frequency broadcasting at infrequent time intervals, such as during

"off-the-air" periods. For these occasional calibration checks the frequency of the master transmitter may be received via radio. This makes possible common-frequency broadcasting without the customary central control over telephone lines, i.e., a direct control of each separate common-frequency transmitter.

Special emphasis has also been placed on rapid frequency changing. Any desired frequency within the provided band (short-, medium-, or long-wave region) may be tuned in, and frequency changing can be accomplished in a few minutes. A continuously tuning self-excited master oscillator stage is provided if it becomes necessary to change frequency suddenly before a new crystal is available. If desired, motor-driven frequency changers can be supplied, which permit frequency-changing in less than one minute.

The required operating reliability is achieved either by having a complete set of spare parts for the most important construction units, or by dividing the transmitter into two independent groups, A and B, each with one-half power output. In the latter case, group A or group B may be operated separately at fifty percent of the total power output, or they may be operated in parallel with full output. Each of the two transmitter chains A and B contains its own power supply and cooling equipment. This type of construction offers the technical advantage of making transmitter breakdown practically impossible, since at least one of the two transmitter chains should be ready for operation; it also makes it possible to carry out necessary overhaul work such as tube replacement on the disconnected chain during transmitting periods. Economically, this type of construction has the possible advantage of permitting shut-down of one of the chains during the

night hours because of more favorable propagation conditions at medium wave-lengths during that period. By decreasing total transmitter power to one-half in this way, a reduction in operating costs may be attained.

Telefunken transmitters also stand out by their excellent broadcast qualities, that is, their low distortion factor, their broad audio pass band, and their very low noise modulation. The transmitters are modulated by the proven Class B plate modulation method. High efficiency and optimum tube utilization are attained by this method of modulation in the r.f. power amplifier stage as well as in the final stage of the modulator, which also is operated Class B. This method of modulation also offers operating convenience, permitting rapid frequency changing in the r.f. installation. A high degree of feedback is utilized in the modulator stages to minimize non-linear distortion.

The transmitter has a harmonic distortion of about two percent for eighty percent modulation at a medium modulation frequency, increasing to about three percent for ninety percent modulation. The frequency response is in accordance with the requirements of radio broadcasting. The deviations at the limiting frequencies of 30 and 10,000 cycles are about 2 db with respect to 800 cycles.

The percentage of stray-voltage modulation is about 0.1 percent (literally 1 $^{0}/_{00}$), corresponding to about -60 db, for equal weighting of all components. The percentage of hum modulation, when frequency-weighted through a filter having an ear-response characteristic, is about 0.03 percent (literally 0.3 $^{0}/_{00}$) corresponding to -70 db.

Modern line termination amplifiers and monitoring installations serve to amplify the modulation voltage delivered by the radio studio and permit testing of the broadcast quality.

For the protection of transmitter installations comprehensive safety equipment is provided, including current, voltage, and temperature overload release mechanisms. The correct starting and shut-down sequence is assured by interlocking circuits. By means of modern ignitron tube protection devices the high voltage is removed from the transmitter immediately in case of tube arcing, that is, even before the start of operation of the regular current overload circuit breaker.

High-frequency transmittion line monitoring installations with cut-out devices for blocking the transmitter in case the maximum permissible mismatch is exceeded, serve for the protection of the transmission line. This equipment assures protection of the installation even in case of un-monitored operation.

Air-cooling is provided for cooling the final amplifier tubes for transmitters with carrier powers from above 5 kilowatts to about 40 kilowatts. For transmitters with power outputs above 40 kilowatts either air-cooling or water-cooling installations can be used. High-power transmitters with output powers above 100 kilowatts are generally operated with water-cooling.

The power supply equipment, which operates in complete silence, is equipped with selenium rectifiers for the amplifier stages and with grid-controlled to oxidized-cathode rectifiers filled with mercury-vapor for the plate-current supply of the final stages. The tube filaments are heated by alternating current. Through

appropriate filtering of the dc voltages and by using Scott filament transformers with phase displacement, a far-reaching reduction of the hum modulation is achieved.

Transmitter and power supply installations are set up in a self-contained type of construction, and are built into a series of metal cabinets which are placed side by side; they are characterized by uniform panel construction and modern styling.

The remote operation and monitoring of Telefunken radio transmitters is carried out from modern control consoles.

The antenna installations in the medium-wave region are supplied in the form of self-supporting tubular or mast towers. For operating wave lengths which are not excessively long half-wave radiators are preferred to increase the field intensity of the ground wave and to enlarge the service area which is free from fading. Omnidirectional and directional beam antennas find application in the short-wave region, the directional beam antennas being constructed in the form of the well-known dipole arrays or as rhombus antennas.

The production program for radio broadcasting installations in the long-wave, medium-wave and short-wave region comprises, in part

1. Complete radio broadcasting transmitter installations for the long-wave region from 150 to 300 kilocycles (2000 to 1000 meters), with carrier powers to about 500 kilowatts at the transmitter output.

2. Complete radio broadcasting transmitter installations for the medium-wave region from 525 to 1610 kilocycles (571.3 to 186.3

meters) with carrier powers of 5, 20, 40, 100 and 150 kilowatts at the transmitter output.

3. Complete radio broadcasting transmitter installations for the short-wave region from 5 to 25 megacycles (60 to 12 meters), or from 3 to 20 megacycles (100 to 15 meters) with carrier powers of 10, 20, 40, 50, and 100 kilowatts at the transmitter output.

2. VHF Radio Transmitters

For radio broadcasting in the v.h.f. region Telefunken has developed a series of frequency-modulated very-high-frequency radio transmitters which are in accordance with the most recent developments of high-frequency techniques and which fulfill the electrical and constructional standards set up by the Rundfunktechnische Institut (Radio-Technical Institute) (RTI). These FM-VHF transmitters of most recent design are characterized by excellent broadcast quality, i.e., low distortion factor, a minimum of noise modulation and a frequency response satisfying the strictest demands. The high frequency stability of these transmitters is also to be noted; it was achieved through a series of circuit-design and constructional improvements in the master oscillator stages. The simple construction, modern protection and monitoring devices and the easy operation are also worth mentioning.

The frequency range of these transmitter installation comprises the v.h.f. radio broadcast band from 87.5 to 100 megacycles (corresponding to 3.4 to 3 meters), provided by the Atlantic City agreement. Within this frequency band the transmitters may be tuned to any desired frequency. Frequency changing can be carried out in the shortest time.

Frequency modulation is achieved in the master oscillator stage by means of a push-pull reactance tube arrangement. A frequency deviation of ± 75 kilocycles represents 100 percent modulation. A deviation of ± 100 kilocycles can be attained by a corresponding increase in modulation voltage.

Transmitter installations are broken up into units with output powers of 250 watts, 3 kilowatts, and 10 kilowatts, in accordance with the "add-on" construction principle. These output power levels are in accordance with the RTI power classifications. Each of the units is housed in a separate metal cabinet. The cabinets used for this purpose are of uniform panel construction and have modern styling.

Each of the previously mentioned three power groups -- 250 watts, 3 kilowatts, and 10 kilowatts -- is equipped with its self-contained power supply. The power supplies associated with the 250 watt and 3 kilowatt final stages are housed in the same cabinets, while a separate cabinet is provided for the power supply of the 10 kilowatt stage.

The matched-unit construction makes possible an orderly stage-by-stage expansion of the transmitter installation, starting with the master oscillator stage of 250 watts output; an additional stage brings the power output to 3 kilowatts, and further additions can result in a power up to 10 kilowatts. This type of construction, on the other hand, permits temporary low-power operation of the complete 10 kilowatt installation. For example, one may operate with only 3 kilowatts or 250 watts into the antenna, for the purpose of overhauling the final stage of the 10 kilowatt

transmitter. For this purpose, the r.f. terminations of the three power groups have been designed uniformly for connection to a balanced 60 ohm transmission line.

Beyond the mentioned power outputs it is possible to attain a further increase in power up to 50 kilowatts. For this latter add-on stage Telefunken supplies a 50 kilowatt VHF final stage which is operated in conjunction with the 10 kilowatt final stage.

The 250 watt cabinet houses the master oscillator with the associated frequency generators, stabilization and modulation circuits, as well as the subsequent frequency changing, frequency multiplier, and the 100 and 250 watt final stages with their associated power supplies. This transmitter unit can be used separately as a 250 watt VHF transmitter, or else as a pre-amplifier cabinet for larger installations with power outputs of 3, 10 and 50 kilowatts.

A 10 kilowatt VHF transmitter is made up by connecting the 3 kilowatt driver stage, which is housed with its power supply in a double cabinet, to the adjoining 10 kilowatt final amplifier stage. The final stage is housed in a single cabinet, while the associated power supply is built into a double cabinet. The 10 kilowatt installation made up in this way from two single and two double cabinets has an overall front length of 4 meters, a cabinet height of 2 meters, and a cabinet depth of about 0.8 meters. This series further comprises a 1 kilowatt VHF transmitter installation, which consists of a 100 watt pre-amplifier cabinet, that is, the regular pre-amplifier unit without the 250 watt stage, and a following 1 kilowatt final power amplifier stage. These two construction units with their associated power supplies are contained

in one double cabinet.

Telefunken supplies v.h.f. antenna installations of advanced design for these very-high-frequency transmitters. For example, antennas may take the form of six-fold U-type antennas or of double-slot antennas, and are characterized by great vertical beaming with the resultant power gain in the horizontal plane. Some also show broad-band qualities. The appropriate matching devices permit simultaneous operation of two to three VHF transmitters from such an antenna array, making it possible to broadcast two or three programs at the same time.

Frequency stability and modulation characteristics of the FM-VHF transmitters:

Frequency Stability:	± 1 kilocycle for 24-hour period
Frequency Deviation for 100% Modulation:	± 75 kilocycles
Harmonic Distortion at 100% Modulation:	less than 1% between 100 and 15,000 cycles
Frequency Response without Pre-emphasis:	± 1 db between 100 and 15,000 cycles
Interference Level Stray Level:	- 60 db
Noise Level:	- 70 db

The production program comprises:

Complete radio broadcast transmitter installations for the VHF region from 87.5 to 100 megacycles (3.4 to 3.0 meters) with frequency-modulation and power outputs of 0.1, 0.25, 1, 3, 10, and 50 kilowatts at the transmitter output.

B. COMMUNICATION TRANSMITTER INSTALLATIONS

Telefunken can supply complete transmitter installations for the commercial radio communication traffic, for press, weather service, etc. These installations include the associated keying and modulation equipment, the required power supplies, cooling and servicing equipment, as well as the appropriate antenna installations. The installations conform to the most advanced techniques of commercial long-distance radio traffic. Especially noteworthy are the improvements incorporated for effecting rapid and convenient frequency changing, which make it possible to shift from one end to the other of the frequency band within a few minutes, even for the largest high-power transmitters. This guarantees the greatest possible speed of radio communications.

The production program comprises, in part:

1. Complete communication transmitter installations for the very-long wave region (or very-low-frequency region) from 1 to 30 kilocycles (20,000 to 10,000 meters) with transmitter output powers to 1000 kilowatts equivalent to 200 kilowatts of radiated power, for telegraphy. (A 1 and F 1 frequency-shift keying operation).

2. Complete communication transmitter installations for the long-wave region from 75 to 150 kilocycles (4000 to 2000meters) with transmitter output powers of 30 to 60 kilowatts, for telegraphy or facsimile operation.

3. Complete communication transmitter installations for the short-wave region from 4.3 to 24 megacycles (70 to 12.5 meters) with transmitter output powers of 20 and 40 kilowatts for telegraphy and facsimile operation.

4. Complete communication transmitter installations for the short-wave region from 5 to 30 megacycles (100 to 15 meters) with transmitter output powers of 5, 20, and 40 kilowatts for telegraphy or facsimile, telephony and picture transmission. These can be switched to AM or FM operation (narrow-band frequency modulation with small frequency deviation), and are available in the following emission types:

Amplitude Keying or Modulation:

A 1 (c.w. telegraphy)

A 2 (tone telegraphy)

A 3 (telephony)

A 4 (picture transmission)

Frequency Shift Keying or Frequency Modulation

F 1 (frequency-shift-keying telegraphy)

F 3 (frequency-modulated telephony)

These installations are equipped with built-in keying apparatus, either for single or double direct-current local keying, or for double direct-current or alternating-current remote keying. Provisions are made for relay- or electronic keying, hard or soft keying, as desired. The keying and modulation equipment is further complemented by a tone-frequency generator for A 2 operation, modulation and line termination amplifiers for tone-modulated telegraphy (MCW) telephony and picture transmission. Special test instruments serve to monitor the input and output modulation performance.

5. Complete communication transmitter installations for the short-wave region from 5 to 24 megacycles (60 to 12.5 meters) for single sideband and double sideband operation (single sideband modulation for multi-channel operation) and with transmitter output

powers of 20 and 40 kilowatts for telegraphy and overseas telephony.

C. TELEVISION TRANSMITTER INSTALLATIONS

Complete television transmitter installations for the 100 megacycle band, containing video and frequency-modulated sound transmitters, with output powers of 3, 5, and 20 kilowatts at the transmitter output. Installations are also available for the 200 megacycle band with powers of 1.5 and 5 kilowatts at the transmitter output.

D. MARITIME TRANSMITTER INSTALLATIONS

The production program comprises, in part:

1. 40-Watt Medium-to-High Frequency Radio Phone Transmitter
   S 109 GW 0.04/1

   Frequency (Wave) Region: 1.6 to 3 megacycles (187 to 100 meters)

This two-stage transmitter is equipped in the oscillator stage with five control crystals, any one of which may be selected; they are used for four traffic channels and the international emergency frequency of the mobile maritime radio service. Frequency stability conforms with the international agreement at Atlantic City. Continuous tuning is provided for alternate frequency and emergency operation. For this purpose the transmitter can be switched to self-excitation, in which case any desired frequency within the given frequency band may be selected. Antenna power is 40 watts without modulation: the range over water is about 500 nautical miles or more, depending on antenna and reception conditions. For normal speech a modulation percentage

of seventy-five percent can be attained. Excellent speech quality is attained by means of a combined plate- and screen-grid modulation. The equipment incorporates a modern tube complement which is restricted to two tube types. Power is supplied by means of a transformer from the ship's 110-volt ac line.

2. 200-Watt Medium-Wave Telegraphy Transmitter

Frequency (Wave) Region: 405 to 535 Kilocycles (741 to 561 meters)

This two-stage transmitter is intended for A 1 and A 2 operation and delivers an output power of 200 watts for A 1 peak power. A pre-tuned reserve channel is provided for the international call and emergency wave length.

3. 200-Watt Shortwave Transmitter

Frequency (Wave) Region: 4 to 30 megacycles (75 to 10 meters)

This two-stage 200-watt short-wave transmitter is intended for A 1 and A 3 operation, and is equipped with six quartz crystals in the oscillator stage, any one of which may be selected.

II. RADIO TELEPHONE AND DIRECTIONAL RADIO RELAY INSTALLATIONS

A. FM-VHF RADIO-TELEPHONE INSTALLATIONS

Telefunken has developed a modern frequency-modulated v.h.f radio-telephone installation for radio-telephony from mobile stations within an area fifty kilometers in diameter, that is, for telephony from land-based vehicles or coastal vessels, as well as between subscribers connected to the postal telephone net. This installation finds application for police and fire departments, customs service, industrial organizations, transportation, railroad ranging, for automobile telephones, and similar services.

The traffic between a vehicle and a central station with associated fixed transmitter and receiver takes place in the form of a two-way conversation, that is, as ordinary telephony. This type operation requires a separate frequency for each of the two traffic directions. The mobile transmitter and one or more fixed receivers communicate on one wavelength; the fixed transmitter and mobile receiver communicate on another wavelength, the mutual frequency separation being about ten to fifteen percent.

This FM-VHF radio-telephone installation, developed by Telefunken according to the most modern design principles, is operated in the frequency range from 70 to 78 megacycles and from 80 to 87.5 megacycles (i.e., the v.h.f. band at about 4 meters), provided for this purpose by the Atlantic City agreement. The frequency range from 70 to 78 megacycles is intended for communications between the vehicular transmitter and the

fixed receiver, while the frequencies from 80 to 87.5 megacycles serve for communications between the fixed transmitter and mobile receiver. Within these frequency regions, different bands are assigned to the various services, and, in turn, within these bands fixed frequency pairs are assigned. Transmitter and receiver are crystal-controlled, both in the fixed station and in the mobile installation. Simple switching provides either an operating or an alternate frequency; the maximum separation between these two frequencies may not be more than 300 kilocycles without circuit re-tuning. Traffic generally takes place in the manner of one central station communicating through the fixed transmitter and receiver with several vehicles on one of the two frequency pairs (operating or alternate frequency). In the event that several radio nets are formed within a city for various vehicular groups, such as traffic, accident and police emergency squads, it is required to maintain channel separations of 150 kilocycles between the various partial nets in order to avoid interference.

Special 160 megacycle installations will soon become available in addition to the standard-type installations which are operated in the frequency region around 80 megacycles. Telefunken VHF-radio-telephone installations utilize frequency modulation for increased freedom from noise and electrical interference.

The fixed transmitter and one or more fixed receivers are connected via telephone lines to the central station, which serves for long-distance service and monitoring, as well as transition point to the regular wire telephone net and vice versa. In other words, the radio connection can be switched through to the telephone line network, or the telephone line connection can be hooked

to the wireless link. Furthermore, the central station permits traffic between the vehicles by operating a simple switch, if it is desired; for example, to utilize one of the mobile stations as a net control station.

The following types of operation exist:

1. Traffic between vehicle and central station.
2. Traffic between vehicles.
3. Traffic between a vehicle and a telephone subscriber.
4. Conference call: vehicle - central station - telephone subscriber.

The production program comprises, in part:

1. 100 Watt FM-VHF Installations

consisting of:

Fixed 100-watt transmitter installation with two pre-set crystal-controlled frequencies in the frequency (wave) region of 80 to 87.5 megacycles (3.75 to 3.43 meters).

Type of Modulation: FM

Transmitter Power Output: 100 watts

Frequency Deviation: ± 17.5 kilocycles

Power Line: 220 volts, 50 cycles ac

Built-in remote control and monitoring equipment.

Fixed Receiver Installation

10-tube superheterodyne receiver with crystal-controlled local oscillator, two pre-set frequencies in the frequency (wave) region of 70 to 78 megacycles (4.29 to 3.85 meters)

Sensitivity: 10 k T

Power Line: 220 volts, 50 cycles ac

Central Station

for modulation of the fixed transmitter and monitoring of

the fixed receiver, remote control and supervision of the fixed installations, as well as for relaying from and to the telephone net; includes built-in interval tone and call-up equipment

Mobile Vehicular Installation

consisting of a 10-watt transmitter, a 10-tube superheterodyne receiver, control box, hand microphone, loudspeaker and common power supply for transmitter and receiver, including a special antenna with switch. Operation is from a 12-volt, 75 ampere hour storage battery.

Special Test Instruments

such as modulation meters, power output meters, etc., as needed for maintenance and repair.

2. 10-Watt FM-VHF Installations

consisting of

Fixed 10-watt transmitter installation;

frequency (wave) region as in (1)

Fixed receiver installation;

10-tube superheterodyne receiver; frequency (wave) region as listed in (1).

Central station for minimum traffic.

Vehicular installation as in (1).

Special test instruments

as in (1).

B. FM-VHF REMOTE PICKUP INSTALLATIONS

Wireless remote pickups have become increasingly popular for radio broadcast reporting, replacing the microphone tied to a cable with its limited radius of action. In remote wireless pickups the radio reporter carries with him a portable transmitter, which enables him to conduct the broadcast in a considerably more lively and realistic manner. Telefunken has developed the new frequency-modulated v.h.f. remote-pickup installation "Teleport" for this purpose, as well as for other services requiring the use of one-way radio communication over a range of several kilometers (i.e., for police, fire departments, border customs service, etc.). The installation consists of a portable transmitter and a receiver for intercepting this transmitter.

The portable remote pickup transmitter, which is operated from dry batteries, features minimum dimensions and is equipped with a high-quality microphone.

The remote pickup receiver, which serves to pick up the emissions of the portable transmitter, is a suitcase-type instrument, and may be operated from the power line or from dry batteries. The output of this receiver may be recorded by a tape recorder, or can be directly transferred to the radio transmitter via a transmission line.

The installation is operated in the v.h.f. band between 70 and 80 megacycles. Two frequency channels within this band are provided for transmitter and receiver. If there is interference on one frequency, it is possible to change to another frequency by simple re-tuning.

Frequency modulation makes possible improved broadcast quality and increased freedom from static and interference. The "Teleport" installation meets the quality requirements of radio broadcast operation and is characterized by low distortion, a broad audio passband, as well as a high-signal-to-noise ratio.

The service range between transmitter and receiver generally is several kilometers. The range is smaller for broadcasts from buildings or under unfavorable terrain conditions, but it is not less than 500 meters in the most unfavorable case.

The FM-VHF Remote Pickup Installation "Teleport"

consists of:

An FM-VHF Transmitter

in portable form, containing a frequency-modulated oscillator, and two fixed pre-set transmitter channels; the radiated r.f. power is about 0.5 watt. A quarter-wave antenna rod of about one meter length can be attached. A Condenser microphone is built in.

Frequency Response:	± 5 db from 40 to 6,000 cycles
Distortion:	less than 1 percent
Power Supply:	Mikrodyn (Microdyne) batteries
Weight of Transmitter:	1 kilogram
Weight of Associated Battery Box:	2 kilograms

Transmitter and battery box are carried by means of shoulder straps.

FM-VHF Receiver

a 12-tube superheterodyne receiver with 10 tuned circuits for fixed and portable use.

Sensitivity: about 10 k T

Line Output: 1.55 volts into 100 ohms

Built-in Monitor Speaker: 1 watt audio output

Frequency Response: ± 2 db between 40 and 8,000 cycles

Distortion: less than 2 percent

Hum level: more than 50 db down

Power Supply: ac line or battery operation

The "Teleport" installations are also supplied as special models for the 160 megacycle band. This "Teleport II" also provides for two-way communications.

C. VHF AND MICROWAVE RADIO RELAY LINKS

The present level of the v.h.f and microwave technique permits the use of radio relay links which are not inferior to wire nets with respect to economy, operating stability, and reproduction quality. Consequently, these radio relays may be successfully integrated into the long-distance communication lines in place of open-wire lines or cable networks. Almost any desired distance can be bridged by switching in an optional number of relay stations. By taking over carrier-frequency techniques or using special pulse-time modulation systems, maximum exploitation of the radio links is made possible and economical operation is assured.

These radio relay links can be utilized in commercial communications to supplement the available cable network, in case special events make it impossible to supply the large demands for lines by the existing wire and cable networks. Furthermore, radio relay links are used successfully in regions without cable or wire services, or where unfavorable terrain conditions make it difficult to lay wire lines. In this case radio techniques offer considerable

advantages, inasmuch as a v.h.f. or microwave link is comparatively quickly erected.

VHF and microwave relays may further be used in radio broadcast service as modulation links between radio studio and transmitter, in case modulation telephone lines are not available, or are of inadequate quality. FM-VHF or microwave radio relay links are manufactured for these applications, and meet the requirements of high-quality radio broadcasting service with respect to frequency response, distortion, and noise level. Television is an additional field of application for radio relay links. Microwave links are now used in preference to coaxial cables for transmitting the video carrier frequency between studio and transmitter, or between various transmitters of a network.

Multi-channel radio relay links are steadily increasing in importance and are taken into account in the planning of new communication nets, or as replacement for coaxial cables and modulation (telephone) lines in radio and television broadcasting. In this way fields of application are opened up to radio techniques which were heretofore reserved to transmission line techniques.

Radio relay links have proven their worth during the last decade in the European communications network. During the last war radio relay links were operated over distances of several thousand kilometers. For example, radio telephone and teletype service was carried on over microwave radio relay links between Norway and Italy and Greece, and temporarily also to the Black

Sea. In some regions of Europe, microwave radio relay links offer the only telephone service.

These microwave radio links were operated almost exclusively with Telefunken equipment, namely the well-known "Michael" and "Rudolf" devices, whose development began in 1937. At the present time these installations are still used by the German Mail Service, and they are integrated into the regular long-distance telephone net. The present-day microwave network of the German Mail Service includes a connection from the North Sea to the Alps, among others.

Based on these many years of experience, and taking into account the most recent results of domestic and foreign research, Telefunken has developed short and long-distance links, as well as a pulse-time modulated installation.

The production program includes, in part:

1. FM-VHF Short-Distance Links for Radio Broadcasting and Commercial Multi-Channel Communications.

Frequency (wave) Region:	155 to 175 megacycles (1.94 to 1.71 m)
Transmitter Power:	100 watts
Type of Modulation:	Frequency Modulation
Frequency Deviation:	± 75 kilocycles or ± 500 kilocycles can be switched in a. Radio broadcast transmission: ± 75 kilocycles maximum b. Commercial communications: ± 500 kilocycles maximum
Audio Range:	a. Radio broadcast - 30 to 15,000 cycles

b. Commercial communications:

up to 12 telephone channels - 300 to 60,000 cycles

up to 24 telephone channels - 300 to 120,000 cycles

Receiver: a. for 75 kilocycles frequency deviation

b. for 500 kilocycles frequency deviation

Distortion: less than 0.5 percent second and third harmonic at full frequency deviation (modulation)

2. FM-VHF Long-Distance Links for Commercial Multi-Channel Communications

Frequency (wave) Region: 41 to 68 megacycles (7.3 to 4.4 meters)

Transmitter Power: 1 kilowatt

Type of Modulation: Frequency Modulation

Frequency Deviation: ± 500 kilocycles maximum

Audio Range: 300 to 60,000 cycles for 12 telephone channels maximum

Distortion: less than 0.5 percent second and third harmonic for full deviation (modulation)

Antenna systems for v.h.f. short and long-distance links are in the form of dipole arrays (Telefunken Christmas tree antennas) and contain 12 or 20 dipole elements, arranged in 3 or 5 rows, respectively, of 4 adjacent dipole elements each; the elements are either single-wire types or broad-band multi-wire (Reusen) types.

Special transmitter and receiver isolation filters have been developed for dual operation of the antenna arrays, that is, for common operation of two receivers or two transmitters on a single antenna system.

3. Microwave Radio Relay Installation "Ida 22" with Pulse-Time Modulation

The new microwave radio relay link "Ida 22" is operated in the 1,700 - 2,300 megacycle frequency region, provided for this purpose by the Atlantic City agreement and permits the simultaneous transmission of twenty-two telephone conversations. A further audio channel is reserved for official traffic. Telephone quality meets the CCIF requirements; the audio passband of each channel extends from 300 to 3,400 cycles. In contrast to previous microwave systems, which utilized frequency modulation, the new microwave installation "Ida 22" provides for pulse-time modulation. In this method multiplexing is achieved through time separation of the individual operating channels, thus eliminating the carrier-frequency equipment required for frequency-channel multiplexing. Special electronic circuits are provided for changing the audio-frequency conversations into phase (time) modulated form.

The transmission system with a time-multiplexed sum channel does not require demodulation at the relay stations; that is, the received pulse series does not have to be re-converted into the audio-frequency region. This eliminates non-linear distortion and avoids the deterioration of transmission quality in long links with several series-connected relay stations. The receiver of the relay station simply detects the r.f. carrier. The resulting time-modulation pulses are used to key the relay transmitter, after they have undergone re-shaping and amplification. Time separation of

the channels has the further advantage, that non-linear distortion at the terminal stations cannot result in over-modulation.

Technical Characteristics of the "Ida 22" Installation

Frequency (wave) Region:	1,700 to 2,300 megacycles (17.7 to 13 centimeters)
Tuning Range: (Transmitter and Receiver)	about ± 5 percent
Transmitter Power:	50 watts peak pulse power
Type of Modulation:	Pulse Time Modulation
Transmission Channels:	22 operating channels 1 service (official) channel
Receiver:	Superheterodyne receiver with automatic search and fine-tuning equipment
Antenna Radiator:	Horn antenna with parabolic reflector

III. COMMERCIAL RECEIVERS

A number of special receivers have been designed by Telefunken for commercial radio communications and radio monitoring of the Mail Service, for use in radio reception by radio broadcasting companies, as well as for press, stock reports, traffic, weather, police and similar applications. The development, construction and manufacture of these receivers is based on Telefunken's long experience in the manufacture of radio communication equipment, and takes into account all progress achieved in recent years in this field. The receivers are equipped with all new features of the latest reception techniques, and are characterized by reliability and high efficiency.

The following gives a short survey of applications and technical data for commercial receivers manufactured by Telefunken. The equipment listed in this tabulation may be classified essentially into three groups:

1. Receivers for commercial radio communications (search and service receivers, test receivers for radio monitoring)
2. Receivers for radio broadcasting companies (network relay receivers and receivers for monitoring transmission quality).
3. Press receivers

In addition Telefunken can supply special FM-VHF receivers for radio public-address installations, i.e., for police and ranging, as well as receivers for FM-VHF remote-pickup installations and FM-VHF radio relay links. These receivers are listed under II.

Receivers for radio direction finding are treated in Section IV.

A. SERVICE AND SEARCH RECEIVERS FOR COMMERCIAL RADIO COMMUNICATIONS

1. Allwave Receiver E103 Aw/1

Frequency (wave) region: 103 kilocycles to 30 megacycles (2910 to 10 meters)

Types of Operation: A 1, A 2, A 3

This modern all-wave receiver has been developed for use in medium-power fixed stations or aboard ships. As ship's receiver, the instrument permits two-way traffic on adjacent frequency channels, even under unfavorable interference conditions, that is, for directly adjacent transmitter and receiver antennas.

Circuit: 9-tube superheterodyne receiver with three r.f. circuits and eleven i.f. stages; bandwidth control in the i.f. portion.

Image Selectivity

Band I: 1:10,000

Band VII: 1:10 to 1:150

Overall selectivity for 9 kilocycles detuning:

Bandwidth ± 7 kilocycles: greater than 1:13

Bandwidth ± 0.5 kilocycles: greater than 1:1000

Sensitivity:

2 to 8 microvolts for 5 volts output into 4000-ohm load

Signal-to-noise ratio: 3:1

Modern Pico-U tube complement

Built-in monitor loudspeaker

Power Supply: 110/220 volts, ac-dc

2. Shortwave Search Receiver E 104/Kw/1

Frequency (wave) region: 1 to 30 megacycles (300 to 10 meters)

Types of Operation: A 1, A 2, A 3

This modern high-quality receiver for radio monitoring and commercial radio traffic is equipped with all features of recent commercial receiver techniques. It is used primarily as operational receiver in large land or ship stations and as search receiver in fixed high-power stations. The over-all receiving range of the instrument is divided into 17 bands. The reception principle utilized assures highest stability and satisfactory band spread. A crystal-controlled local oscillator and tunable first i.f. stage is provided.

Circuit:

13 tube double-superheterodyne receiver with 3 radio-frequency circuits, crystal controlled local oscillator tunable first i.f. with four tuned circuits, frequency changing to a second fixed intermediate frequency with quartz crystal and 3 double-tuned filters.

Bandwidth in the second i.f. portion is continuously variable between ± 0.5 and ± 6 kilocycles.

Built-in crystal calibration oscillator.

Modern Pico-E tube complement.

Image Selectivity for 9 Kilocycles Detuning:

Bandwidths ± 6 kilocycles: 1:1000

Sensitivity: 10 k T

Tuning accuracy and calibration.

Length of frequency dial 400 millimeters, 2.5 respectively 5 kilocycles/millimeters

Power Supply: 110/220 volts ac

3. Medium and Long Wave Search Receiver E 108/LW/1

Frequency (wave) Region: 9 to 4100 kilocycles (33,400 to 73 meters)

Types of Operation: A 1, A 2, A 3.

The medium and long-wave search receiver is also intended as test receiver and for commercial radio press service.

Circuit:

13 tube superheterodyne receiver with image-frequency filter (Lw), resp. four radio-frequency stages (Mw), crystal filter and four double-tuned band filters in the i.f. portion.

Bandwidth in the i.f. portion is continuously variable between ± 0.5 and ± 6 kilocycles.

Built-in crystal calibration oscillator.

Modern Pico-E tube complement.

Image Selectivity: greater than 1:10,000 over the whole range.

Adjacent Channel Selectivity for 9 kilocycles detuning:

For wide-band operation of ± 6 kilocycles: 1:1,000

Sensitivity: 10 k T

Tuning and calibration accuracy:

Dial lengths 400 millimeters, 650 cycles to 3.5 kilocycle millimeters.

Over-all reception range is divided up into 5 bands.

Power Supply: 110/220 volts ac

4. High Power Station Receiver for Fixed Services

High power station receivers are supplied for overseas radio traffic between fixed points, that is, for large receiving stations of the commercial radio communications service. The receivers can be supplied for single side band multi-channel telephone diversity receiving installations. The main component of these installations is two short wave receivers, type E 104/Kw/1, which are equipped for the service with automatic frequency control.

Adaptors for triple superheterodyning, channel separation and frequency fine tuning, automatic release for diversity operation, as well as the required test and monitoring installations complete the technical equipment of these modern receiving installations, which are constructed by the DIN standard method.

B. MONITOR AND NETWORK RELAY RECEIVERS FOR RADIO BROADCASTING COMPANIES

1. Radio Broadcast Monitor Receiver 9 H 99 Wu

Frequency (wave) region: (590 to 185 meters). 510 to 1620 36.5 to 101 megacycles (3.47 to 2.97 meters)

This special instrument was created for the monitoring of the transmission quality of radio broadcast transmissions in the medium wave and VHF region; it is equipped with a 10-watt woofer-tweeter loudspeaker combination, which permits monitoring of high-quality transmissions.

Circuit:

9 tube superheterodyne receiver

FM-VHF: 2 r.f. stages, 6. i.f. stages

Medium wave: 2. v.f. stages, 4. i.f. stages with continuously variable bandwidth

Built-in 10-watt woofer-tweeter loudspeaker combination

Audio quality:

Radiated frequency band 40 to 12,000 cycles within ± 4 db

Power Supply: 110/125/150/220/240 volt ac

2. Radio Broadcast Network Relay Receiver Ball E-1.

Frequency (wave) regions: 150 to 400 kilocycles (2,000 to 750 meters)

510 to 1620 kilocycles (590 to 185 meters)

6 to 13 megacycles (50 to 23 meters)

12.5 to 25 megacycles (24 to 12 meters)

This instrument is designed for radio broadcast network relay reception of radio broadcast companies. In this method of reception the emission of a transmitter is received with a radio receiver and is relayed as modulation to another transmitter. Inasmuch as the network relay receiver in this case replaces the modulation transmission line quality of such receivers must meet very high requirements. Radio network relay receiver ball E-1 has correspondingly high quality transmission characteristics. Built-in instruments serve to indicate field intensity and volume level at the transmission line termination.

Circuit:

12 to superheterodyne receiver with 3 radio-frequency stages (variable bandwidths for medium and long waves) and 6 i.f. stages (3 filters with continuously variable bandwidths).

Transmission line termination:

4 volts into a 600-ohm load, source impedance 30 ohms.

Loudspeaker output:

5 volts into a 5-ohm load (5 watt)

Audio quality:

Frequency response: ± 1 db between 30 and 15,000 cycles

Distortion: Less than 2% for 4 volts into 600 ohms

Hum Level: More than 60 db down

Power Supply: 220 volts ac

3. Radio Broadcast FM-VHF Net Work Relay Receiver EB/UK/3/1.

Frequency (wave) region: 87 to 100 megacycles (3.5 to 3 meters)

This network relay receiver which is intended for the reception of frequency modulators VHF radio transmitter, is characterized by high pre-selection and selectivity as well as by outstanding audio quality. The receiver is increasingly used for network relay links of the VHF radio networks for the transmission of programs from station to station. Built-in test instruments permit monitoring the field intensity, frequency deviation, and frequency separation of the transmitter being received The receiver may be used as a VHF calibration receiver. The receiver may be used as table instrument or as a DIN standard receiver.

Circuit:

16-tube double-superheterodyne receiver with three radio-frequency circuits and 11 i.f. stages. Double frequency conversion, crystal-controlled second oscillator

Image Selectivity:

1st l.f: larger than 1:5000

2nd i.f: larger than 1:50,000

Adjacent Channel Selectivity for 800 kilocycles detuning: 1:100,000

Sensitivity: 6 k T

Line Output: 1.55 volt for loading 300 ohms; source resistance 50 ohms

Voice Coil Output: 1.5 watt, 15 ohms impedance

Audio quality at line output:

Frequency Response: ± 1 db between 30 and 15,000 cycles per second

Distortion: less than 1 percent

Hum Level: more than 60 db down

Power Source: 220 volts ac

Network Reception Installation with two EB/UK 3/1

A special automatic switching device has been developed for the v.h.f.-network relay receiver which is operated in conjunction with two such receivers. For example, if receiver I should fail, the carrier received by this unit is automatically switched to receiver II. Both network relay receivers, the automatic switching device and the monitor loudspeaker are built into DIN standard racks, forming in this way a complete FM-VHF receiving installation.

C. PRESS RECEIVERS

1. Press Facsimile Receiver E 11-1/48

Frequency (wave) region: one fixed frequency within range from 40 to 150 kilocycles (7500 to 2000 meters)

This four-stage four-tube tuned radio-frequency receiver was produced for the reception of facsimile transmissions distributed via radio by the press agencies. Continuous tuning has been intentionally sacrificed in the interest of maximum economy. The receiver is pre-tuned to the desired operating frequency; frequency changing is achieved by exchanging a plug-in tuning capacitor assembly.

Circuit:

4-tube, 4-stage t.r.f. receiver with four pre-tuned r.f. circuits.

Direct-current output for facsimile printer

Selectivity for 5 percent detuning: 1:1000

Power Source: 220 volt dc 110/150/220 volts ac

2. Press Facsimile Receiver EPH/L/2

Frequency (wave) Region: 40 to 160 kilocycles (7500 to 1875 meters)

This special receiver, also intended for facsimile reception, is based on the superheterodyne principle and is equipped with continuous tuning, as well as effective automatic regulation. The receiver circuit makes possible adequate facsimile reception, even for strong local and atmospheric disturbances.

Circuit:

5-tube superheterodyne receiver with one tuned r.f. stage and four i.f. stages. Direct-current output for facsimile printer

Selectivity for 5 percent detuning: greater than 1:1000

Sensitivity: 10 microvolts

Power Source: 220 volts dc or ac

3. Shortwave Press Receiver EP/K/1

Frequency (wave) Region: 6 to 18 megacycles (50 to 16.6 meters)

Types of Operation: A 1, A 2, A 3

This receiver is intended primarily for press reception.

Circuit:

10-tube superheterodyne receiver with two r.f. stages and six i.f. stages. Built-in monitor loudspeaker.

Power Source: 220 volts ac

IV. DIRECTION FINDING INSTALLATIONS

Based on its long experience in the manufacture of portable, mobile, and fixed direction-finding installations for air and sea navigation, which have proven outstanding in all continents, Telefunken has developed new Adcock direction finders and crossed-loop goniometer direction-finding installations.

1. Goniometer Direction Finder "Telegon"

Frequency (wave) Region:

196 to 3530 kilocycles (1530 to 85 meters) in four bands, or

214 to 535 kilocycles (1400 to 560 meters) in a single band

Types of Operation: A 1, A 2, A 3 broadcast reception and direction finding

Primarily intended for fishing boats, coastal and ocean shipping, but also usable as coast or land station, this installation is characterized by a high bearing sensitivity. The direction-finding receiver is a superheterodyne unit with high image and adjacent channel selectivity, variable i.f. bandwidth, and affords a tuning and calibration accuracy, which - by utilization of a large circular dial with friction drive - meets all demands of commercial traffic. The receiver is equipped with a built-in direction-finding adapter with a special iron-goniometer and a large bearing (aximuth) dial. Quadrantal direction-finding errors (deviations) can be compensated electrically.

A built-in checking device permits spot performance tests of the overall system with antenna, thus making possible rapid trouble-shooting. A simple switch makes possible a rapid transition from direction finding to radio reception, and vice versa. In accordance with its application, the entire direction-finding

installation is sea-water proofed.

Receiver:

6-tube superheterodyne receiver

Built-in direction-finding adapter with (soft) iron goniometer, direction-finding sense switch and [deblurring] null-regulator. Receiver unit with r.f. pre-amplifier, mixer stage, two i.f. stages, diode detector, audio output stage, and beat-frequency oscillator (for c.w. reception)

Modern Pico-E tube complement

Bandwidth switching in the i.f. circuit in four ranges: ± 0.5 kilocycles to ± 7 kilocycles

Broad-band tuning for sea distress traffic: ± 12.5 kilocycles

Antenna System:

Fixed crossed loop, consisting of two single of 1.2 meter diameter each, which are mounted at right angles to each other. The loops are supported by a heavy pole. The auxiliary (sensing) antenna is ordinarily symmetrically arranged in the crossed-loop system. Two wire antenna lead-ins, balanced to ground, run from the loops to the receiver, while a single-wire lead-in is used for the sensing sntenna. Special cables with fixed shielding are used for these connecting lines, which can be up to eight meters in length.

Direction-finding Performance:

A 1 (cw) transmitters are d-fed with a minimum null width of about ± 0.5 for a field intensity of 30 microvolts per meter.

Power Supply:

24-volt battery. (The plate voltage is generated through

a separate vibrator ac supply with tube rectifier.)
Emergency operation from a storage battery and 120-volt B-battery is provided.

2. Adcock Direction Finding Installations

a. Short-Wave H-Adcock Direction Finder Type H 10/38
(fixed or mobile)

Frequency (wave) Region: 7.9 to 30 megacycles (38 to 10 meters)

This installation makes possible accurate direction-finding which is largely independent of the type of polarization and the angle of elevation. It is equipped with an antenna array consisting of six dipoles that is designed to avoid local antenna reflections and the attendant decrease of bearing accuracy. Very accurate bearings are attained, even without using the minimum nullwidth sharpening, because of the inherently small null width of the equipment. The total system bearing error is about 0.5 degree on the shortwave end of the frequency range, i.e., at about 30 megacycles. Because of the type of antenna array used, no inherent null errors occur.

The direction-finding operator's house is designed to eliminate reflections on the antenna system.

Direction-Finding Performance: 1 degree for 6 to 15 microvolts/ meter (A 1 operation)

The direction-finding house and antenna system of the mobile version can be loaded into a truck and trailer.

b. Shortwave U-Adcock Direction Finder Type U 38/100
(fixed or mobile)

Frequency (wave) Region: 3. to 7.9 megacycles (100 to 38 meters)

The antenna system of this U-Adcock installation consists of six masts of 8 meters length each, which are erected as a sextagon

in base circle of 12 meters diameter.

These antenna masts are mounted on disc-type insulators and are held by guy wires. The construction and dimensions of the antenna system are such that only small system errors occur at the short-wave end of the frequency range.

D-F Performance: 1 degree for 4 to 8 microvolts/meter (A 1)

c. VHF Rotatable Adcock Direction Finder Type HD 1/10 (vehicular version)

Frequency (wave) Region: 30 to 300 megacycles (10 to 1 meters)

The VHF Rotatable Adcock Direction Finder Type HD 1/10, which has been developed especially for vehicular services, permits bearings on both horizontally and vertically polarized waves.

The receiving range is divided into four bands. The d-f receiver is equipped with AM-FM switchover.

Antenna System:

Vertical pole with two 45 degree crossed extension elements. These dipole extension elements are exchangeable to permit selection of the optimum antenna system for each frequency band. Bearings on 180 degree horizontally polarized waves can be made within the direction-finding range (wavelength from 10 to 1.78 meters) by changing the position of the dipole elements.

Direction-Finding Performance:

± 5 degrees for 20 to 40 microvolts/meter (A 1 operation). Direction-finding performance varies somewhat for the various frequency bands, and is — in part — better than stated above. The listed value also applies for horizontal polarization.

V. GENERATORS AND GENERATOR INSTALLATIONS FOR HIGH FREQUENCY HEATING

The application of high-frequency heating enables more economical fabrication methods in many industrial fields and often permits an improvement in quality of the manufactured products. Since the more efficient execution of labor processes is nowadays of primary interest, high-frequency heating is gaining an increasingly prominent place in industrial fabrication processes.

Inductive high-frequency heating finds application in the heating of metallic work materials and is used for surface-hardening of machine parts, final heating of metals in vacuum for degassing, melting, sintering, welding, tempering, etc. In this method the heating energy is transferred to the work piece by means of a coil through which radio-frequency currents are made to flow.

Capacitive or dielectric heating is used for uniform heating of non-conductors, such as plastics, wood, rubber, ceramic materials, glass, etc. Dielectric heating is based on the effect of an electric field on the material to be heated; the material is inserted between the plates of a high-voltage capacitor. Capacitive heating of dielectric materials has a decisive advantage in some fabrication processes in that the heat does not have to be conducted to the material from the outside which generates a heat potential but heating is generated uniformly within the work piece. Dielectric heating finds application in synthetic industries for pre-heating of materials to be molded, for welding of plastic materials, the manufacture of layer-type insulating materials; furthermore in wood working for drying and gluing, in

the tire industry for vulcanization, in the food industries for sterilization and curing of cereals and other food products, and in the pharmaceutical industry for drying of sensitive materials, etc.

Telefunken has developed a number of modern tube generators and tube generator installations for both high-frequency heating methods, i.e., for inductive and dielectric heating.

1. High-Frequency Generators with Output up to 7 Kilowatts

a. High-Frequency Generator HFG 100/kw 1.5/2 for dielectric heating

High-frequency power output	1.5 kilowatts
Operating frequency	18-20 megacycles
Power Source	220 volts, 50 cycles ac

b. High-Frequency Generator HFG 100/kw 1.5/3 for dielectric heating with work space and asymmetrical r.f. output

High-Frequency Power Output	1.5 kilowatts
Operating Frequency:	18-20 megacycles
Power Source	220 volts, 50 cycles ac

c. High-Frequency Generator HFG 100/kw 1.5/4 for dielectric heating, with two work place connections

High-Frequency Power Output	1.5 kilowatts
Operating Frequency	18-20 megacycles
Power Source	220 volts, 50 cycles ac

d. High-Frequency Generator HFG 100/kw 1.5/5 for dielectric heating, with four work place connections

High-Frequency Power Output	1.5 kilowatts
Operating Frequency	18-20 megacycles
Power Source	220 volts, 50 cycles ac

e. High-Frequency Generator HFG 104/kw 4/1 for dielectric heating

High-Frequency Power Output	4 kilowatts
Operating Frequency	15-20 megacycles
Power Source	3 phase, 380 volts, 50 cycles

f. High-Frequency Generator HFG 101/Mw 1.5/2 for inductive heating

High-Frequency Power Output	1.5 kilowatts
Operating Frequency	450 kilocycles
Power Source	220 volt, 50 cycles ac

g. High-Frequency Generator HFG 105/Mw for inductive heating

High-Frequency Power Output	7 kilowatts
Operating Frequency	450 kilocycles
Power Source	three phase, 380 volts, 50 cycles

2. High-Frequency Generator Installations with Outputs above 7 Kilowatts

a. Generator installations for dielectric heating with outputs of 15, 30, and 60 kilowatts and operating frequencies of about 20 megacycles; also units with power outputs of 18, 35, 70 and 140 kilowatts with operating frequencies of about 5 megacycles for connection to three-phase 380 volts, 50-cycle supplies.

b. Generator Installations for inductive heating with power outputs of 20, 35, 70, 140 and 200 kilowatts with operating frequencies of about 450 kilocycles for connection to three-phase, 380 volt, 50-cycle supplies.

VI. TEST AND MONITORING EQUIPMENT

A. LINE (TERMINATION) AMPLIFIERS AND MONITORING INSTALLATIONS

Telefunken has brought out a new radio transmitter test set for complete testing of the reproduction quality of radio broadcast transmitters. The installation comprises a high-quality line (termination) amplifier at the transmitter end of the modulation (telephone) line and a series of additional monitoring devices. The monitor portion of the installation permits rapid performance of the operating quality checks required in broadcast stations including continuous visual modulation indication, as well as continuous monitoring of broadcast sound quality. This central monitoring of the operating condition enables the operating personnel to perform quick trouble-shooting in case equipment failure should be experienced. The following tests and measurements may be carried out:

1. Measurements of Modulation percentage

   with simultaneous indication of the effective and peak modulation percentage

2. Display of the Dynamic Modulation Characteristic

3. Output Level Measurements

   in the audio range, utilizing a built-in voltmeter, a calibrated vacuum tube voltmeter with r-m-s indicator; test ranges from five millivolts to fifteen volts.

4. Determination of Noise Modulation

   a. Control through measurement of total noise voltage with equal weighting of all interfering components.

   b. Determination of the subjective interference effect by means of noise level measurements, which have been frequency-compensated through a loudness curve filter.

5. Frequency Response Measurements (audio passband of transmitter)

for the audio range of 20 to 20,000 cycles.

6. Distortion Measurements

Determination of non-linear distortion through distortion factor measurements at 110, 800, and 3000 cycles; distortion factor ranges from 5 to 15 percent

or:

Measurement of intermodulation distortion through determination of the difference tone contact in the range from 200 to 15,000 cycles; accessory equipment for intermodulation tone is provided. Square and cubic distortions from 0.3 to 15 percent can be measured. An additional test position is provided for low-frequency testing, using an alternate test method.

7. Display of Oscillograms

of high-and low-frequency phenomena; for example, the modulation envelope of an r.f. carrier wave or the trapezoidal transmitter modulation oscillogram; observation of audio-frequency oscillations at the input and output of the modulator, etc.

8. Monitoring of Dynamic Volume Range

with optical modulation indicator, according to the most recent recommendations of the broadcast companies.

9. Audio Monitoring of Broadcast

through monitor amplifier and speaker. The modulation meter and monitor amplifier can be switched to either the input of the output of the transmitter, enabling a comparison of the quality of the incoming with the radiated modulation. The installation is comprised of three cabinets, according to DIN 41 490.

The line termination amplifier rack is housed in one of the three cabinets and contains:

A line termination amplifier for operation

A line termination amplifier for reserve

A monitor amplifier

A modulation monitor with separate optical indicator.

The two remaining cabinets - the monitor racks - contain:

A r.f. test detector

A modulation monitor

An R-C audio generator with a range from 20 to 20,000 cycles

A distortion filter for non-linear distortion measurements

or:

A double-tone transmitter and receiver for distortion according to the double tone (intermodulation) method.

An oscilloscope

A voltmeter (audio-frequency amplified vacuum-tube voltmeter)

Test Positions.

The required test set-ups may be hooked up rapidly by means of jumper connectors. The circuit schematic of any test arrangement is easily visualized, since the test connector pairs are identified by circuit symbols, that is, they are arranged in the order of the circuit paths engraved on the front panel.

A series of open positions are provided for the addition of test and monitor equipment, or recording devices, thus permitting an orderly expansion of the installation. The instruments, which are constructed as replaceable racks with knife contacts, are also available as table models on request.

A special version of the line amplifier and monitoring installation is supplied for FM-VHF radio broadcast transmitters. Among other modifications in this model, the test detector and modulation meter are replaced by a discriminator with deviation meter.

B. MONITORING INSTALLATION FOR RADIO-FREQUENCY TRANSMISSION LINES

This test equipment is designed for continuous monitoring of r.f. carrier power and of antenna transmission line matching; provision is made for automatically disconnecting the transmitter, when the maximum permissible mismatch is exceeded.

The installation consists of the following components:

A transmission line monitoring instrument,
available in short, medium, and long-wave versions, the instrument is inserted into the transmission line at the transmitter output and thus is traversed by the total antenna current.

Electrodynamometer
for direct indication of transfer power (r.f. carrier power), antenna mismatch, as well as for measurement of the maximum line voltage occurring during mismatch conditions (i.e., SWVR)

Cut-Off Device
for automatically disconnecting the transmitter when the maximum permissible mismatch is exceeded.

Reconnecting Device
with step relay and mechanical register; this equipment is used in conjunction with the automatic cut-off device

for temporary disconnection and automatic reconnection of the transmitter in case of large momentary mismatches caused by arc-overs. In the event of continuously high mismatch, the transmitter is permanently disconnected, after a test sequence of five cut-offs and reconnections.

Special mismatch test instruments are available for monitoring of v.h.f. transmission line in the very high frequency (vhf) range. In contrast to the previously mentioned short, medium, and long wave test instruments, which operated independently of frequency, the v.h.f. tester permits frequency-selective mismatch measurements. This eliminates the re-radiation and mutual influence via the associated antenna system, in the event that several transmitters are utilized in one station.

The VHF Mismatch Test Equipment Consists of:

A test instrument, which is connected into the path of the v.h.f. transmission line (Z = 60 ohms) and, hence, is traversed by the antenna current.

An r.f. terminal board with six pairs of receptacles for connecting six test positions

An Indicator

circuit-wise this instrument consists of a three-stage calibrated amplifier with four tuned circuits and contains a meter which is calibrated directly in percent mismatch. The input of this indicator is connected to the desired test position on the r.f. terminal board by means of two flexible r.f. lines which have plugs on the ends. The indicator and terminal board are designed for mounting in a DIN standard rack.

C. RAPID ANTENNA TUNING DEVICE

This test instrument permits rapid tuning and matching of the radiator in medium-wave transmitter installations, enabling frequency changing in the briefest possible time. A built-in cathode-ray tube serves as indicator for cleanly phased tuning.

VII. TUBES, QUARTZ CRYSTALS, CAPACITORS

A. TRANSMITTER, AMPLIFIER, AND RECTIFIER TUBES

Telefunken electron tubes are the result of basic research investigations in the Telefunken Laboratories. The production schedule comprises:

1. Transmitter Tubes

for long-wave, short-wave, and v.h.f. operation:

a. Radiation-cooled tubes

b. Air-cooled tubes

c. Water-cooled tubes

2. Amplifier Tubes

3. Rectifier Tubes

a. High-vacuum rectifier tubes

b. Mercury vapor rectifier tubes with [ignitrons] or without grid control.

B. QUARTZ CRYSTALS

Telefunken quartz crystal oscillators and resonators are designed for use in master oscillators, frequency standards, filters and related applications; they are characterized by single moding, high calibration accuracy, small temperature coefficient, low damping, as well as by insensitivity to shock and freedom from ageing processes. The production schedule comprises:

1. Built-in Crystals

with miniature holder made of cylindrical plastic material, available for frequencies from one to thirty megacycles.

2. Vacuum-Type Crystals

with reduced damping, tropicalized and altitude-proofed;

reliable operation, even for rapid temperature changes between -50 degrees centigrade and +80 degrees centigrade; salt-water and acid resistant; built into a metal tube holder with plastic socket; connection is made by insertion of two four millimeter plugs, spaced 19 millimeters apart; available for frequencies from 450 kilocycles to 30 megacycles. Crystals for frequencies below 450 kilocycles are available on request.

Calibration Accuracy and Temperature Coefficient of Crystal Types listed under 1. and 2. above:

Calibration Accuracy

for series resonance, as well as for any desired circuit with known parameters; 1×10^{-5}

Between individual crystals: 1×10^{-4}

Temperature Coefficient

within an interval of ± 10 degrees centigrade about the temperature operating point: 1×10^{-4} per degree centigrade

3. Common-Frequency Crystals

For especially high demands on frequency accuracy and stability Telefunken can supply quartz crystals oscillators which are intended for installation in crystal ovens along with their associated oscillating circuit components. The temperature coefficient of these crystal oscillators is 1×10^{-7} within an interval of ± 0.5 degrees centigrade about the temperature operating point. These crystals can be supplied for frequencies between 500 kilocycles and 3 megacycles.

C. MICA CAPACITORS

Telefunken supplies high-quality mica capacitors for trans-

mitter construction which are characterized by high power loading ability for small volume, high temperature stability, high mechanical ruggedness and long life. The production program comprises:

1. Flat Metal Plate Capacitors

for small equipment (transmitters and receivers) with capacitance values from 10 pico [micromicrofarads ?] farads to 200,000 picofarads maximum power rating up to 500 VA, depending on capacitance.

2. Column-type (cylindrical) Capacitors

for transmitters (also special types for short-wave transmitters), with capacitance values from 50 to 200,000 picofarads maximum working voltage up to 8 KV, depending on capacitance; maximum power rating up to 100 KVA, depending on capacitance.

3. Oil-Filled Capacitors

especially for high-power transmitters, with capacitance values from 100 to 25,000 picofarads; maximum working voltage up to 17 KV, depending on capacitance; maximum power rating to 800 KVA, depending on capacitance.

Other values and ratings available on request.

D. VACUUM CAPACITORS

Among other features Telefunken vacuum capacitors for transmitter construction are characterized by remarkably small dimensions. At present, these capacitors can be supplied with capacitance values of 50, 100, 200, and 500 picofarads.

Maximum peak voltage:	20 kilovolts
Maximum r.m.s. current of the 50-picofarad capacitor	
up to 30 megacycles	50 amperes
at 100 megacycles	30 amperes